NPDγ: A Precision Measurement of the Parity-Violating Gamma Asymmetry in the Capture of Polarized Cold Neutrons by Para-Hydrogen

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The NPDγ experiment intends to measure the parity-violating γ-ray asymmetry (A_γ) with respect to the neutron spin in the capture of cold polarized neutrons on para-hydrogen, $\vec{n}$ + p $\rightarrow$ d + γ, to a relative precision of 10^{-8} or better. In the meson exchange model of the weak nucleon-nucleon interaction, the long-range potential is determined by the lightest meson, the pion. The weak π-nucleon coupling constant f_π^1 is the dominant contributor to A_γ, and it has not yet been directly measured. Existing experimental extractions of f_π^1 are obscured by nuclear uncertainties in the description of the processes. NPDγ will perform the first clean measurement in the *np* system which will stimulate theories of nuclear parity violation.

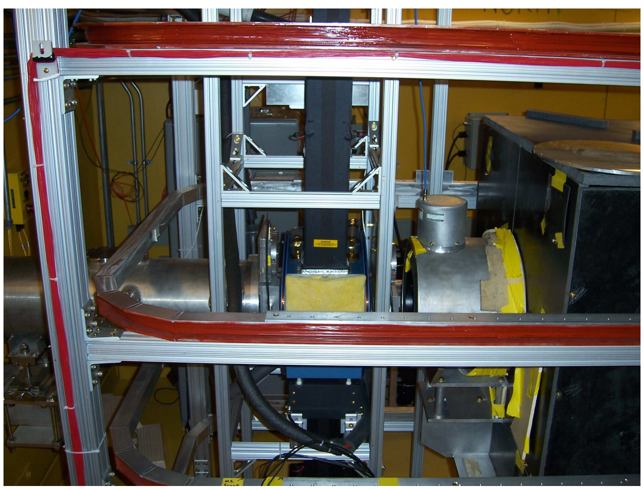

FIG. 1: The NPDγ experimental setup at LANSCE. The guide coil system (main and shim coils), and, from left to right, the neutron guide, the ^3He spin filter, the RF spin flipper, and the CsI detector array.

In 2004 we finished the installation of the apparatus (Fig.1) at the Los Alamos Neutron Science Center (LANSCE), except for the liquid para-hydrogen target. Berkeley was responsible for building a precision 10 Gauss guide coil system with a gradient of less than 1 mGauss/cm over the entire experiment (Fig.2). It was designed to preserve the neutron's spin direction. In order to deal with disturbances from a 11 Tesla magnet in the neighboring experimental area, we have designed and mounted additional shim coils. These allow us to correct for homogeneous magnetic stray fields which vary by 200 mGauss in our target region.

In spring 2004 the first cold neutron beam entered the NPDγ cave. We maintained polarizations of 40 - 50 % in our ^3He spin filter and measured a high spin flipping efficiency (~95%). The spin flipping allows us to minimize systematic

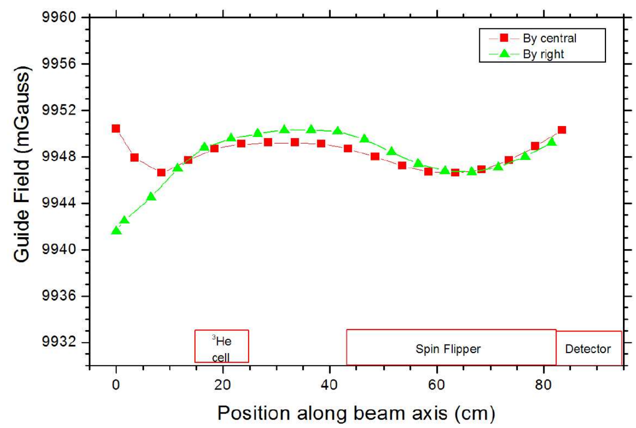

FIG. 2: Guide field measured along the beam axis in central and right position. A small remanence magnetization, of the neutron guide is visible (at 0). It does not disturb the experiment.

errors, due to e.g. detector asymmetries or slowly changing efficiencies, by averaging the neutron spin direction.

After commissioning the apparatus, the first physics data were taken. We have observed a γ-ray asymmetry in $CCl_4 = 19 \pm 2 \times 10^{-6}$. ^{35}Cl shows a well known parity violation effect. This measurement demonstrated the ability of the apparatus to detect small γ-ray asymmetries. We also measured asymmetries in $B_4C = 5 \pm 3 \times 10^{-6}$ and $^{115}In = 3 \pm 2 \times 10^{-6}$. In addition, we checked our target construction materials ^{27}Al and ^{59}Cu and can now exclude a background asymmetry contribution on the 10^{-7} (Al) and 10^{-6} (Cu) level. False asymmetry contributions from detector noise and electronic pickup can be excluded on the 5×10^{-9} level.

The first hydrogen production data-taking at LANSCE is foreseen for the fall 2005 beam cycle, with the goal of reaching 5×10^{-8} sensitivity. After successful runs at LANSCE we are planning to move the experiment to the fundamental neutron physics beamline at SNS, which would allow us to make a 10% measurement of the predicted γ-ray asymmetry in radiative $\vec{n}p$ capture.

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